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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/653,561	08/31/2000	Larry Hillyer	M4065.0239/P239	5354
24998	7590	06/06/2005	EXAMINER	
DICKSTEIN SHAPIRO MORIN & OSHINSKY LLP			NGUYEN, HA T	
2101 L Street, NW			ART UNIT	
Washington, DC 20037			PAPER NUMBER	
			2812	

DATE MAILED: 06/06/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

09/653,561

Applicant(s)

HILLYER ET AL.

Examiner

Ha T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 23 February 2005.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-4, 6-18, 20-31, 34-39, 41-44, 50, 52-82, 84-95 and 97 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-4, 6-18, 20-31, 34-39, 41-44, 50, 52-82, 84-95 and 97 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

## **DETAILED ACTION**

### ***Notice to applicant***

1. Applicants' Amendment and Response to the Office Action mailed 11-24-4 and the Request for a Continued Examination filed 3-18-5 have been entered and made of record . Following is an Office Action responding to the request.

### ***Claim Rejections - 35 USC § 112***

2. Claims 50, 52-69, 92-95, and 97 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The independent claims 50, 54, 92, and 95 appear to recite each of the plasma process steps does not form silicon oxide. This is not true since the specification discloses that in the two step process the first plasma is a conventional oxygen plasma, (see first par. of page 13) which would oxidize the exposed portion of the opening including bottom and side walls .

Claims 52-53, 55-69, 93-94, and 97 variously depend from claims 50, 54, 92, and 95, they are rejected for the same reason.

### ***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was

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commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103 and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

4. Claim 54 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al. (USPN 6204192, hereinafter "Zhao"), in view of Chen (USPN 5970376).

Referring to Figs. 1-8 and related text, Zhao discloses a method for removing polymer etch residue from an etched opening in a silicon wafer device, comprising the steps of: contacting said opening with a first plasma to remove a portion of said etch residue, stopping said first plasma contacting before said polymer etch residue is completely removed and thereafter removing any remaining said residue by contacting said opening with a second plasma, said second plasma consisting of a hydrogen containing gas (See col. 4, line 37- col. 5, line 39). Zhao also discloses removing photoresist by oxygen ashing (see col. 1, lines 54-63). It is inherent that some residue is also removing in the ashing step. Because the second plasma reducing any existing silicon oxide, the first and the subsequent contacting with said first and said second plasma prevent the formation of silicon oxide in said opening. But it fails to disclose expressly first plasma consisting of oxygen. However, the missing limitation is well known in the art because Chen discloses this feature (See cols. 10 and 11).

A person of ordinary skill is motivated to modify Zhao with Chen to remove photoresist by a conventional process .

Therefore, it would have been obvious to combine Zhao with Chen to obtain the invention as specified in claim 54.

Note: Because of the large number of claims the following rejection will mainly address the claimed features without, at every rejection, specifically indicate the identification number of all the claims containing the rejected features.

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5. Claims 1-4, 6-18, 20-31, 34-39, 41-44, and 54-91 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao in view of Smith (USPN 6277733)

[Re claims 1, 16, and 29] Zhao discloses substantially the limitations of claims 1, 16, and 29, as shown above. But it fails to disclose expressly the use of  $\text{NH}_3$  and the removal of nitride by phosphoric acid.

However, the missing limitations are well known in the art because Smith discloses that ammonia and  $\text{H}_2$  are equivalent gases for removing organic containing material (see col. 4, lines 8-26). In the case where ammonia is used, it is inherent that nitride is formed and the cleaning of opening by phosphoric acid as conventionally done removes residue including the formed nitride.

[Re claims 54 and 70] Zhao discloses substantially the limitations of claims 54 and 70, as shown above. But it fails to disclose the first plasma of oxygen. However, Smith discloses that photoresist is etched with plasma of oxygen (see col. 3, lines 37-55).

[Re claims 2 and claims reciting similar feature(s)] Smith also discloses wherein said opening is a HAR contact opening (see Fig. 2f);

[Re claims 3 and claims reciting similar feature(s)] wherein said contacting is performed under conditions effective to remove said etch residue without substantially increasing the size of said opening (See col. 1, 54-56); and

[Re claims 4 and claims reciting similar feature(s)] wherein said opening is contacted with ammonia,  $\text{H}_2$ , or  $\text{CH}_4$  gas in the absence of oxygen (See col. 4, lines 8-48).

[Re claims 6 and claims reciting similar feature(s)] Zhao also discloses wherein said contacting with said second plasma is done at a temperature within the range of about 250-500° C (see col. 5, lines 5-22);

[Re claims 12-13 and claims reciting similar feature(s)] wherein said contacting with said second plasma is performed for a period of less than about 100 seconds; for a period of not more than about 75 seconds (see col. 5, lines 23-39);

[Re claims 14 and claims reciting similar feature(s)] forming a conductive layer at the bottom of said opening following said contacting step (see col. 5, lines 40-51);

[Re claims 15 and claims reciting similar feature(s)] in the case nitrogen containing plasma is used for the second plasma silicon nitride is formed at a bottom of said opening (see

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col. 4, lines 17-36), and the removal of said silicon nitride by phosphoric acid is a conventional practice to clean up the opening ;

[Re claims 26 and claims reciting similar feature(s)] wherein said bottom of said opening is not oxidized during said second plasma contacting step (see par. bridging cols. 4 and 5).

[Re claims 7-11 and claims reciting similar feature(s)] Zhao discloses substantially the limitations of claims 7-11 and claims reciting similar feature(s), as shown above. But it fails to disclose expressly the details about said opening and the conditions for applying the first or second plasma. However any variation in parameters in the present claims is obvious in light of the cited art, because the changes in parameters produce no unexpected function.

The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter variation produces an unexpected result. In re Aller, Lacey and Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406.

[Re claims 41-44] Zhao also discloses wherein an insulating layer is formed on said device prior to said etching and said etching forms a contact hole in said insulating layer by dry etching; said dry etching is performed using at least one gas selected from the group consisting of  $\text{CH}_2\text{F}_2$ ,  $\text{CHF}_3$ ,  $\text{CH}_2\text{F}_6$ ,  $\text{C}_2\text{HF}_5$ ,  $\text{CH}_3\text{F}$  (See col. 4, lines 17-36).

Therefore, it would have been obvious to combine with to obtain the invention as specified in claims 1-4, 6-18, 20-31, 34-39, 41-44, 54-82, and 84-91.

6. Claims 50, 52-53, 92-95, and 97 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao in view of Smith, as applied above, and further in view Kawai (USPN 6284664) and Hamada (USPN 6291890).

The combined teaching of Zhao and Smith discloses substantially the limitations of claims 50, 52-53, 92-95, and 97, as shown above.

But it fails to disclose expressly forming an insulating layer over a polysilicon region; forming a Ti silicide layer at the bottom of said opening in contact with said polysilicon layer.

However, the missing limitations are well known in the art because Kawai discloses forming an insulating layer 18 over a polysilicon region 14; forming a contact opening in said insulating layer down to said polysilicon region using a fluorine containing gas (see col. 4, lines

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4-18); removing polymer residue from said contact opening using a gas (see col. 4, lines 26-58) and Hamada discloses forming a titanium silicide 111 at the bottom of an opening in contact with said polysilicon layer 104; forming a conductor 112 in said opening in electrical contact with said silicide (see Fig. 3D and col. 5, lines 1-20).

A person of ordinary skill is motivated to modify Zhao and Smith with Kawai and Hamada to obtain improved connection conductivity to a gate region.

Therefore, it would have been obvious to combine Zhao and Smith with Kawai and Hamada to obtain the invention as specified in claims 50, 52-53, 92-95, and 97.

### ***Response to Amendment***

7. In view of Applicants' cancellation of the claim, the rejection of claim 83 has been rendered moot.

In view of Applicants' arguments and the amendment to the claims, the objection to claims 30-31, for informality, has been withdrawn.

In view of Applicants' arguments and the amendment to the claims, the rejection of claims 16 and 29 under 35 U.S.C. 103 over the combination of Zhao and Chen has been withdrawn.

Applicants' arguments with regard to the other rejections under 35 U.S.C. 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued that Zhao in view of Chen does not teach "contacting said opening with a first plasma to remove a portion of said etch residue, stopping said first contacting; and subsequently contacting said opening with a second plasma to remove the remainder of said polymer etch residue, said first plasma being generated from a gas other than hydrogen containing gas and said second plasma being generated from a gas consisting of hydrogen gas, wherein said first and said subsequent contacting with said first and second plasmas are configured to prevent the formation of silicon oxide in said opening". The examiner disagreed, even though Zhao only expressly discloses one step of cleaning residue with hydrogen plasma, Zhao also discloses a step of removing photoresist by ashing (conventionally done with oxygen plasma), as shown in the rejection. The examiner argued that the oxygen plasma used to remove the photoresist also inherently remove the etch residue. It is well known in the art that the etching

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of openings in low k dielectric material containing at least organic portions results in polymeric residue, which is inherently removed by oxygen plasma (see Chen, par. bridging cols. 2-3). Because the oxygen plasma photoresist removing step is performed before the hydrogen plasma etch residue removing step, the contacting with oxygen has to stop before all the residue is removed and the remaining residue, including the metal oxide residue caused by the exposure of metal to oxygen plasma, is removed by the hydrogen plasma. If there is no resist left after the oxygen plasma then there is no need for a hydrogen plasma cleaning. Note that applicants' first plasma is also a conventional oxygen plasma (see first par. of page 13), therefore the same effects would have been obtained.

Note that applicants' arguments are largely directed to what the cited references teach individually. However, it is axiomatic that one cannot show nonobviousness by attacking references individually where the rejection, as here, is based on a combination of references. *In re Young*, 403 F.2d 754, 159 USPQ 725 (CCPA 1968); *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981). For example, applicant argues that Zhao or Smith does not disclose two plasma process for removal of etch residue as here claimed. However, Zhao in combination with Smith, is employed in the rejection to show that feature of the claimed process. Zhao discloses the first step of oxygen ashing to remove the photoresist and a second step of hydrogen plasma to remove residues. Smith discloses oxygen plasma ashing photo resist and the equivalence of ammonia, hydrogen and methane plasma in the removal of organic materials included in the etch residue, as shown in the rejection. The combined teaching teach the first plasma generated from oxygen, a gas different from hydrogen containing gas and the second plasma of hydrogen containing gas, including ammonia, hydrogen, or methane. By the cleaning using two plasmas, silicon oxide formation is prevented. In the case ammonia is used for the second plasma, nitride of silicon is inherently formed by the bombardment of nitrogen ion on the bottom and sidewalls of the opening, this would be removed by a conventional phosphoric acid cleaning.

Therefore, the combined teaching of the applied references does teach or make obvious all the limitations of the rejected claims.

### ***Conclusion***



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8. The prior art relevant to the disclosure of this application and not being used in the rejections.

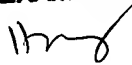
US Patent 6461934 to Nishida et al. and 6534393 to Zhou et al for teaching the use of phosphoric acid to etch silicon nitride.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha T. Nguyen whose telephone number is (571) 272-1678. The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week. The telephone number for Wednesday is (703) 560-0528.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt, can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

**HA NGUYEN**  
**PRIMARY EXAMINER**



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